At the west heading the material encountered varied from mud and shale, carrying considerable water, to sandstone and shale. The water encountered at this heading was not sufficient to impede progress. Some swelling ground was encountered, which necessitated considerable retimbering, and nine shifts were lost on this account. At the west heading 541 feet of sides and arc lining and 257 feet of bottom were placed. The tunnel, as a whole, is about 82 per cent completed. At Indian Creek dike and on the Indian Creek diversion canal melting snow and frequent rains have kept the ground too wet for any construction work. At Strawberry Dam a small force was engaged in overhauling equipment, operating the sluicing tunnel, and other like duties. At the east portal of Strawberry Tunnel the shaft for the controlling works was completed and excavation of the portal cut commenced.

## SNOW SLIDES AND SLIPS.

By LEON PEUGEOT, Superintendent Burro Mine, Utah.

During my years in the hills I have had ample opportunity to become well acquainted with snow slides; and having noted conditions existing previous to various slides, I believe that a little study by the man on the ground may often be the means of saving life and property.

My knowledge of slides was obtained in the vicinity of Burro mine, located on Black Mountain, in the Wasatch

Showing how in a "break slide" the snow breaks away to some underglazed surface. Note the wall of snow about 5 feet high in the background. The author of this article is seated on the underglazed surface.

Range, 8¾ miles as the crow flies from Salt Lake City and 7 miles from Bountiful. The mine camp is located in Howard's Hollow, named after a Mr. Howard, a Mormon pioneer, who, with his oxen, met his death at this point in a snowslide while snaking logs for use in connection with the building of the Mormon Temple.

Howard's Hollow is an immense draw or basin starting from the west side of the ridge and running to Mill Creek below, a distance of a mile and a quarter. The camp lies a quarter of a mile below the crest of the ridge, the ridge altitude being about 10,500 feet and the camp altitude above sea level being about 10,000 feet. The altitude of the creek is about 8,500 feet. The angle of the slope from the ridge to the camp is 39°, and the angle from the camp to the creek is 26°. The slide zone is from the ridge to the creek.

Slides depend on numerous things—weight of snow, warmth, sudden cold, excess of snow at a given angle, the nature of the underlying snow, and the temperature and the weather that prevailed when the first snows of the season were laid. In fact this early snow has much to do with the most dangerous and damaging of all slides, namely, the "to-the-ground slides," which are to be feared more than all others, for they carry more ice and solids, and they shear all in their path—make a clean sweep, so to speak.

Next in point of danger is the "break slide." This gives way to some underglazed surface, say, from 2 to 4 feet down. This is dangerous to man and beast, but not necessarily to buildings and other property, because it will be confined to the layer which broke away and slide over all beneath. Another is the surface or fresh snowslide, and to man this rarely does more damage than to frighten him, although smothering is possible and death might result from that cause.

In this locality January, February, and March are the usual slide months, and each succeeding month of these is more dangerous than the preceding one. As a rule the snow slides down before April 1, and slides seldom occur in December. However, one should be watchful at all times when the ground is snow covered, and especially so in February and March.

Previous to snowslides the air is frequently moist, the mist heavy, and the exposed parts of the observer feel sticky, or more as if a damp rag were pressing the skin. The snow is soggy and occasional glimpses of trees and timber give the impression that they are sweating a sort of mildew. The bright sun and clear-day slides are the ones, however, that swell the death lists; for it is on such days that the foreman orders his men out for timbers, never giving a thought to the stillness of the atmosphere, the depth of the snow, the density thereof, the temperatures of the past few days, or (the most essential and vital point) the early snows of the season. If you should question him as to the possible danger of a slide he would laugh at you and probably tell you that the snow is solid enough to bear up a troupe of elephants, or that it can not slide until it melts enough for the water to soak through and take the frost out of the ground, or other indefinite reasons.

In the early part of 1911 a snowslide occurred at Alta, Utah, that caused the death of several men and a large loss of property and business delays. To my mind this catastrophe would have been reduced to a minimum if proper forethought had been given. Alta, compared to this locality, is nearly identical and only a few miles separate the two camps. The day in question gave me every reason, from my own experiences, to expect a slide. We were in need of mine timbers, but I advised the foremen to hold the men indoors. I was so sure of the slide probabilities that I even went to the kitchen and instructed the cook to keep a low fire, saying that if the slide did come he should rush to the stove and put out his fire. Shortly afterward the slide came. It may have been a lucky guess on my part, for I do not believe that anyone can predict a slide to a day.

We often hear of men seeing a slide coming, running 50 or 100 feet, and hanging on to a tree until the slide passes. This is pure fiction. When it comes to a genuine slide, you do not see it coming; if you saw anything it would be gone almost instantly. A snow slip may start from a footfall, a heavy gust of wind, a blast, or a jar. It is simply a case of very dry snow piled on a hard, glassy surface at a steep angle, a little urging of which causes it to slip. It is not caused by its own weight as a slide proper is, but rather by the lack of moisture, the iced surface, and the dryness of the fresh fall.

The fan or wagon-wheel slide is another variety of slip. If there is a fall of from 2 to 4 inches of snow on a moist surface and the sun comes out warm and the pine boughs with little dabs of snow on their branches seemingly grow suddenly weary of holding them and let them drop simultaneously, they start rolling down the hill, growing larger

and larger and narrower and narrower until they become like so many 5-foot wagon wheels. About this stage of their growth they will wobble precisely like a wheel coming off a buggy and fall flat, starting hundreds of other little wheels going.

The appearance of the slope afterwards is like a large-ribbed fan, and at the end of each rib lies a flat disk for a tassel. A swishing noise accompanies the construction of this immense fan, about as loud as a fan of this size would make if some giant were using it. There is no danger in this kind of a slip or slide except to loose objects.

There are two other conditions that may cause needless terror when slides are quite impossible. The first, or crust drop, is brought about by a flaky fall of a few inches of snow on a solid undersurface followed by snow which comes in small round, hard pellets resembling tapioca and varying in size from one-sixteenth to one-fourth inch in diameter. It is almost as hard as hail, and is the meanest snow the mountain man has to contend with. It is nearly impossible to shovel it, for it runs like so much grain, and when driven by the wind cuts one's face and fills every nook and crack or space. A knot-hole in a building, if not plugged, will furnish entry for a roomfull of tapioca snow. It is very difficult to walk on.

After the fall of tapioca snow sunshine and warmth may come, with a freeze at night. This forms a hard crust thick enough to prevent a man's weight from breaking through it. The crust itself has little support from its snow fluff beneath, merely the strength of the layer itself, and the small brush here and there prevents its dropping. In walking along, the snow will suddenly drop from under one's feet, and, like waves at sea, the snow ahead goes up and down for 50 or 100 feet, producing a startling effect, but not in the least dangerous.

The second harmless affair is due to a sudden drop of temperature that causes the snow to crack open with reports like that of a small cannon. These crevices are often a hundred feet or more in length and vary from 1 to 2 inches in width. This is an indication of the solid, frozen state of the snow to a great depth, and is simply due to contraction by the intense cold. Never have I known a slide to follow immediately such an occurrence, and those that did come, later in the season, did not give way at these places.

A menace to life and property that must not be overlooked is the snow cone or crest. This is caused by the wind blowing the snow over a ridge. Seldom more than one is formed in the same place during the winter, for the making of them is a slow process. Each day as the wind sweeps the flat surface of the ridge the snow is blown over, causing the snow platform to slowly spread out and hang over the basin below. On warm days at the edges where the sun strikes thawing ensues, and the wind sweeping dry snow from shaded portions of the ridge onto and over these melting edges turns it into ice and builds them farther outward.

This awning-like crest will often project a distance of 20 or 30 feet before the overhanging weight and is sufficient to send it tearing down the hill, crushing all in its path. An efficient remedy for these evils is to dynamite the crest by simply loading a 6-foot log with dynamite, sinking it horizontally about 3 feet deep in the top of the snow ridge as nearly over the base of the cone as can be judged. When the fuse is lighted and the explosion occurs one may see a miniature slide in action.

The real avalanche of snow or death-dealing "to-the-ground slide" is the one to be given the most thought. The man on the ground must note the contour of the country, the angles, cliffs, tree belts, hog backs, etc., for they all play an important part in the formation of heavy slides. The first snows are the ones to be noted carefully. It is then that the foundation is laid for the subsequent to-the-ground slides.

Suppose the snow at this early stage is packed hard and, the surface slightly thawing, a storm of tapioca snow comes; the melting surface holds the tapioca from running down hill, the round pellets sinking to a depth of about 2 inches and cementing lightly as they fall. This is followed by a wet blanket of flaky snow of a few inches, then followed by a cold wave, and the ideal foundation is laid for a to-the-ground slide. The cold penetrates through the light blanket of snow and the state of affairs that formerly existed is entirely changed.

First, the former melting hillside surface has become an ice layer or crust; second, the pellets of tapioca snow between the outside crust and the roof or blanket crust have contracted and separated, each pellet becoming a little round ball for future snow to slide upon. Other snows come, higher and higher piles the mass on its unstable foundation; winter has set in, and the snows in texture are fluffy and light. Later on come the thaws, and as the temperature changes so does our source of trouble, 6 or 10 feet below. The snow settles, water penetrates to the ice cover or blanket crust, where its downward progress is halted, and it trickles down the angle of the hill, and slowly but surely wears and weakens the ice arch it travels over. The storms of winter have banked huge drifts in spots and the extra weight at these points causes the weakened arch below to give way, and the overhead load drops on the little hard balls of tapioca that the ice arch sheltered.

The immense weight of snow rapidly gains momentum and the to-the-ground slide has started, beyond all human power of stopping.

Similar conditions may occur more than once, as described above, during the early winter, but the danger is materially reduced with each slide, as the volume of snow to move will usually not be so great, and they assume the features of the break slide, always giving way at the top layers first. This is possible because they are formed in colder weather and are not so securely iced together, sometimes slipping down in succession in midwinter, creating a buffer or blockade at the bottom of the slide region which tends to hold other slides from coming down.

Camp buildings in the mountains should be constructed of heavy timbers and should be set into the hill so that the roof has the same slope as the hill. Any space appearing between the back of the building and the face of the hill should be lagged across a few feet below the roof and filled up even with the hillside. The air space below the lagging protects the inside walls from damp and mold. The doors should always open inward. The smoke pipe should never be braced with tie rods or a snow slide will tear the roof off; only the first joint or so should be braced, and that with ordinary wire, and as the snow depth increases 2-foot lengths may be added without wiring. Buildings should never be placed one below another like steps, but on the same elevation or level. Timber or brushwood should not be cut directly above the camp, as it holds some of the snow from sliding. At a reasonable distance above the camp there should be dug an open trench, about 6 feet deep and 6 feet wide, in the shape of a crescent, the prongs pointing down the hill to the right and left of the camp. This forms a protection from falling rocks and from cloudbursts in the summer time; and during the melting season it turns the water from above away from the camp, permitting the camp to be the first dry spot to show on the mountains.